



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<p>(21) International Application Number: <b>PCT/NL99/00299</b></p> <p>(22) International Filing Date: 17 May 1999 (17.05.99)</p> <p>(30) Priority Data: 1009170 14 May 1998 (14.05.98) NL</p> <p>(71) Applicant (for all designated States except US): SKF ENGINEERING &amp; RESEARCH CENTRE B.V. [NL/NL]; P.O. Box 2350, NL-3430 DT Nieuwegein (NL).</p> <p>(72) Inventors; and</p> <p>(75) Inventors/Applicants (for US only): JACOBSON, Bo, Olov [SE/SE]; Zeallinjen 20, S-224 73 Lund (SE), IOANNEDES, Eushathios [GR/NL]; Montessorilaan 9, NL-3706 TB Zeist (NL). WAN, George, Tin, Yau [GB/NL]; 12 Wolverton Drive, Wilmslow, Cheshire SK9 2GD (GB).</p> <p>(74) Agent: DE BRUIJN, Leendert, C.; Nederlandsch Octrooibureau, Scheveningseweg 82, P.O. Box 29720, NL-2502 LS The Hague (NL).</p>		<p>(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).</p> <p>Published <i>With international search report.</i></p>
<p>(54) Title: COATED ROLLING ELEMENT BEARING</p> <p>(57) Abstract</p> <p>A rolling element bearing comprises an inner ring (3) and an outer ring (2) each provided with a raceway (4, 5), said rings having land regions (10, 11) on opposite sides of their raceways, and a series of rolling elements (6) which are in rolling contact with the raceways, and which are mutually spaced by a cage (7), said cage (7) engaging the land regions (10, 11) of said ring, and at least one of said rings (2, 3) being coated. Said at least one ring is coated with a wear and friction reducing, elastic coating over its full surface.</p> <p>The diagram illustrates a cross-section of a rolling element bearing. It features two rings, an inner ring (3) at the bottom and an outer ring (2) at the top. Both rings have raceways (4, 5) on their inner and outer surfaces respectively. Between the rings is a cage (7) containing a series of rolling elements (6). The outer ring (2) has land regions (10, 11) on its inner surface, which are in contact with the rolling elements (6). The inner ring (3) is shown with a hatched area (9) indicating a coating applied to its outer surface. The cage (7) is also indicated with a hatched area (8).</p>		

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Coated rolling element bearing

The invention is related to a rolling element bearing comprising an inner ring and an outer ring each provided with a raceway, at least one of said rings having land regions on opposite sides of the respective raceway, and a series of rolling elements which are in rolling contact with the raceways and which are mutually spaced by a cage, said cage engaging the land regions of said ring, said land regions being coated.

Such rolling element bearing is known from EP-B-531082. The rolling elements are spaced by a cage, which rides on the lands provided on one of the rings next to the raceway thereof. Such bearing has the advantage that the cage is guided by the ring in question, which improves the dynamic behaviour of the ring and reduces whirl instability.

According to EP-B-531082, a hard coating is applied to each land of the ring, but not to the raceway thereof. Thereby, flaking off under the influence of the locally very high compressive forces which occur in the rolling contacts between the rolling elements and the raceways, is to be avoided.

The object of the invention is to provide a rolling element bearing in which the problem of the coating flaking off will not occur, which enables a relatively cheap manufacturing method, and whereby a proper guidance of the cage is maintained. This object is achieved in that said least one ring is coated with a wear and friction reducing, elastic coating over its full surface.

The coating applied both on the lands as well as on the raceway and the other surfaces of the bearing ring being elastic, several advantages are obtained. First of all, it provides a desired guidance of the cage, such that swirl instability is avoided.

Secondly, the coating will not flake off from the raceway, in particular in case the coating has a thickness which is less than the depth beneath the raceway at which the shear stresses resulting from the rolling motion of the rolling elements, are maximal. A relatively thin layer can deform easily and follow the elastic deformation of the steel base material, when the ball rolls over the raceway. In contrast, in the case of a relatively thick coating, the stresses in the coating layer will be high and spalling or flaking off is more likely. Also a thick elastic coating is more difficult to adhere to the steel than a thin coating due to internal stresses in the coating layer.

As a consequence, according to a third advantage the bearing can be manufactured in an economic way. The layer thickness can be very small. Moreover the full surface of the bearing rings may be coated which is easier than coating only the lands thereof.

5 An advantage of a very small coating thickness is that the topography of the steel raceway is maintained, as a result of which the dynamic behaviour of the bearing is not impaired.

10 According to a preferred embodiment, the coating comprises a diamond-like carbon coating. In particular, the coating may comprise a metal containing diamond-like carbon, for instance alternating layers of metal such as W or WC and a hard 15 morphous coating, such as diamond-like carbon.

According to a further embodiment, the coating may comprise of boron-nitride (BN), chromium nitride (CrN), hafnium nitride (HfN) or any other nitride, oxide such as boron oxide, or carbide or sulphide coating.

15 The maximum coating thickness may be about 2 µm; preferably, the maximum coating thickness is 1 µm.

Reference is made to US-A-5112146, related to a rolling element bearing, the rings of which have a very hard, low fiction coating. Said coating however does not act as a support for a cage, nor is the entire surface of the bearing rings fully coated.

20 The coating can be deposited by means of physical vapour deposition (PVD), chemical vapour deposition (CVD) or pulsed laser deposition (PLD) techniques or through surface treatment like Ion Implantation or laser cladding or glazing.

In addition the hard coating can be further enhanced by another top coating 25 that creates solid lubrication, thereby creating a very smooth interface between cage and ring through transfer of a solid lubricant layer to the counterface.

Such coating can be MoS<sub>2</sub> or WS<sub>2</sub>, e.g. for applications where dry running in the rolling contact is possible.

The invention will further be described with reference to the deep groove ball bearing shown in the figure.

30 The figure shows an axial cross-section through a deep groove ball bearing 1, having an outer ring 2 and an inner ring 3, each provided with a respective raceway 4, 5. The raceways 4, 5 are in rolling contact with a series of balls 6. These balls are mutually spaced by a cage 7, containing pockets 8.

The cage 7 is supported by the inner ring 3. In order to avoid swirl of the cage, the inner ring 3 has a coating 9 over its full surface. Thus, not only the raceway 5, but also the lands 10, 11 bordering the raceway 5, as well as the rest of the outer surface of the inner ring 3 are coated.

5 The full coating of the outer surface of the inner ring 10 has the advantage that the proper, non-flaking surface of the raceway is obtained, as well as a proper, swirl-free guidance of the cage.

Claims

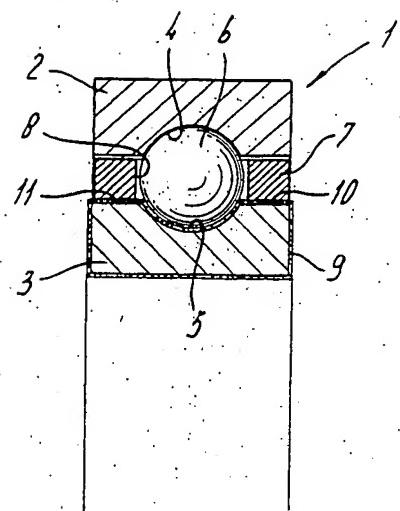
1. Rolling element bearing (1), comprising an inner ring (3) and an outer ring (2) each provided with a raceway (2, 3), at least one of said rings having land regions (10, 11) on opposite sides of the respective raceway (5), and a series of rolling elements (6) which are in rolling contact with the raceways (4, 5) and which are mutually spaced by a cage (7), said cage (7) engaging the land regions (10, 11) of said ring (2, 3), said land regions (10, 11) being coated characterized in that said at least one ring (3) is coated with a wear and friction reducing, elastic coating (9) over its full surface.
2. Bearing (1) according to claim 1, wherein the coating (9) has a thickness which is less than the depth beneath the raceway (4, 5) at which the shear stresses resulting from the rolling motion of the rolling elements (6), are maximal.
3. Bearing (1) according to any of the preceding claims, wherein the coating (9) comprises a diamond-like carbon coating.
4. Bearing (1) according to any of the preceding claims, wherein the coating (9) comprises a metal containing diamond-like carbon.
5. Bearing (1) according to claim 4, wherein the coating (9) comprises alternating layers of metal and diamond-like carbon.
6. Bearing (1) according to any of the preceding claims, wherein the coating (9) comprises boron-nitride or hafniumnitride or niobiumnitride or carbonnitride.
7. Bearing (1) according to any of the preceding claims, wherein the coating (9) comprises boron-oxide.
8. Bearing (1) according to any of the preceding claims, wherein the coating (9) comprises two coating layers, consisting of a supporting coating of a hard

material and on the steel base material, and a MoS<sub>2</sub> or WS<sub>2</sub> coating layer on top of the supporting coating.

9. Bearing (1) according to any of the preceding claims, wherein the maximum coating (9) thickness is 2 µm.

10. Bearing according to any of the preceding claims, wherein the maximum coating (9) thickness is 1 µm.

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# INTERNATIONAL SEARCH REPORT

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PCT/NL 99/00299

<b>A. CLASSIFICATION OF SUBJECT MATTER</b> IPC 6 F16C33/62 F16C33/38		
According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b> Minimum documentation searched (classification system followed by classification symbols) IPC 6 F16C		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practical, search terms used)		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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